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MULTIFOCAL OPHTHALMIC LENSES

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This invention relates to lenses and more particularly to multifocal ophthalmic lenses.

Many types of lenses have been employed in spectacles or eye glasses to correct one or more defects in the vision of the wearer. Frequently a wearer may need more than one pair of eye glasses and thus he may use one pair for normal usage and a second pair for close work such as reading. Although the use of two pairs of eye glasses will enable a person with weak vision to compensate for such vision, such use is extremely inconvenient and annoying to the wearer who is constantly required to keep two pairs of spectacles with him or search for the pair of spectacles he needs for a particular use, but which he has mislaid.

The solution to such a problem was the use of spectacles having bifocal lenses. These bifocal lenses are designed so that the lower sector of each lens has a dioptric power considerably higher than that of the upper sector. By so designing lenses a wearer no longer needs to have two pairs of spectacles, one for normal usage and one for close work such as reading, drafting, etc. The bifocal lenses enabled the wearer to look through the upper sector of the lens to correct the eyes for normal usage and to look through the lower sector of the lens having higher dioptric power for detail work or reading.

While bifocal lenses solved the problem of inconvenience and annoyance, they created an additional disadvantage of their own. A bifocal lens has a sharp line of demarcation where the upper sector of the lens meets the lower sector having higher dioptric power. This discernible line of demarcation produces an annoying blur before the eyes of the wearer when looking through the lens at that line.

This invention overcomes such a disadvantage by providing a lens having a gradually and continuously increasing dioptric power from the upper sector of the lens to the lower sector without any abrupt transition near the vertical axis of the lens such as occurs at the line of demarcation of bifocal lenses of the conventional type. In designing such a lens, which may be termed a multi-focal lens, a further problem is introduced. This problem results from the fact that a multifocal lens must inevitably possess some amount of astigmatism in some part thereof. If the amount of astigmatism is too great, it will destroy the sharpness of the views seen through the lens. Therefore in an acceptable design the amount of astigmatism must not exceed about ⅜ diopter in the central part of the lens and not substantially more than ⅞ diopter and preferably ⅝ diopter at the margin. Hence, this invention further provides a lens having a dioptric power gradually increasing from the top of the lens to the bottom without the amount of astigmatism produced by any part of the lens becoming objectionably high and exceeding the limits set forth above.

The ophthalmic lens constituting this invention has a special multifocal surface on one face of the lens, preferably the rear face of the lens or the face nearest the eye of the wearer. The other face of the lens may be given a spherical, cylindrical or toroidal form adapted to compensate for the imperfections of the eye of the user. The shape of the lens having this multifocal surface is best described in reference to a vertical plane tangent to the lens at the center thereof. The contour lines of such a lens surface when referred to this reference plane are in the upper sector of the face of the lens concave downward near the vertical axis of the lens and convex downward near the marginal portions; and in the lower sector of the face of the lens are convex downward near the vertical axis and concave downward near the marginal portions. The lens has a difference in dioptric power which increases gradually and continuously from the top of the upper sector to the bottom of the lower sector and has no discernible line of demarcation along the vertical axis of the lens between the portions of different dioptric power. The difference in dioptric power may be from -1 at the top of the upper sector to $+1$ at the bottom of the lower sector or, for example, from -6 diopters at the top of the upper sector to -4 at the bottom of the lower sector. In the examples given above, the difference in dioptric power, or "add," has been 2 diopters. However, any other "add" not excessively high may also be used. In addition in the present lens the astigmatism does not exceed ⅜ diopter in the central part of the lens and not substantially more than ⅞ diopter and preferably ⅝ diopter at the marginal portions.

The invention will be described further in connection with the drawings which illustrate several embodiments of the invention. However, it will be understood that these embodiments of the invention are by way of exemplification and not by way of limitation and the invention is limited only to the extent set forth in the appended claims.

In the drawings,

Figs. 1, 2, 3, and 4 show one embodiment of my invention,

Fig. 1 is an elevational view of a lens showing the lens surface divided into two areas for purposes of computation hereinafter referred to,

Fig. 2 is an elevational view of a lens showing the contour lines of the surface of the lens with reference to a plane tangent to the lens surface at its middle point and with the contour lines being placed at 0.02 mm. intervals,

Fig. 3 is an elevational view of a lens showing the distribution of dioptric power with lines placed at ⅛ diopter intervals to indicate changes in the mean dioptric power,

Fig. 4 is an elevational view of a lens showing the distribution of the amount of astigmatism with lines placed at ⅛ diopter intervals to indicate changes in the amount of astigmatism,

Figs. 5, 6, 7, and 8 show a second embodiment of the invention,

Fig. 5 is an elevational view of a lens showing the lens surface divided into six areas for purposes of computations hereinafter referred to,

Fig. 6 is an elevational view of a lens showing the contour lines of the surface of the lens as with reference to a plane tangent to the lens surface at its middle point and with the contour lines placed at 0.02 mm. intervals,

Fig. 7 is an elevational of a lens showing the distribution of dioptric power with lines placed at ⅛ diopter intervals to indicate changes in the mean dioptric power,

Fig. 8 is an elevational view of a lens showing the distribution of the amount of astigmatism with lines placed at ⅛ diopter intervals to indicate changes in the amount of astigmatism,